

December 1997

Preliminary Data Summary

by Field Research Facility

U.S. Army Corps of Engineers
Waterways Experiment Station
Coastal and Hydraulics Laboratory
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Preface

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Corps of Engineers Waterways Experiment Station, Coastal and Hydraulics Laboratory (CHL), Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

Data from these reports are now available via the World Wide Web at
<http://www.frf.usace.army.mil>

These web pages contain general information about the Field Research Facility and data from 1980 to the present.

Your comments and suggestions are welcome.

Introduction

1

The U.S. Army Corps of Engineers Waterways Experiment Station, Coastal and Hydraulics Laboratory (CHL), Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.75 m above the National Geodetic Vertical Datum (NGVD) of the year 1929.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local bathymetric, oceanographic, and meteorological conditions. This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Clifford F. Baron at (252)261-6840 ext.222 (c.baron@cerc.wes.army.mil).

Chapter 2 presents the meteorological data; Chapters 3 through 6 present oceanographic data; Chapter 7 presents nearshore profiles and bathymetry; and Chapter 8, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used and their operational status during the month. Figure 2 shows weather and ocean conditions for the month. Table 2 and Figure 3 identifies the location of the instruments. The water depths at the wave gauges and current meters vary and may be determined from information contained in Figure 9. Other installation information is contained in Table 2.

Times given in the report are referenced to eastern standard time (EST).

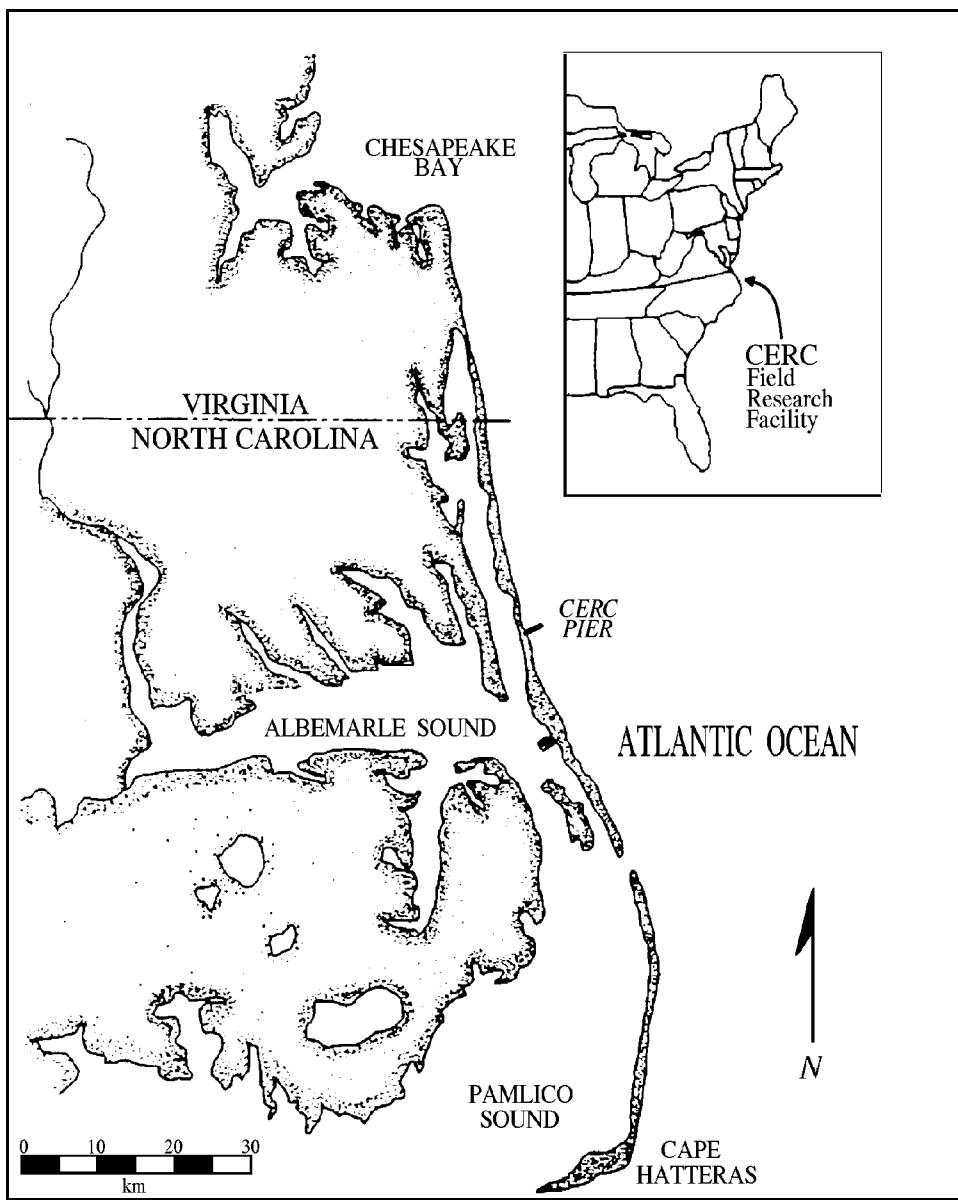


Figure 1. FRF Location Map

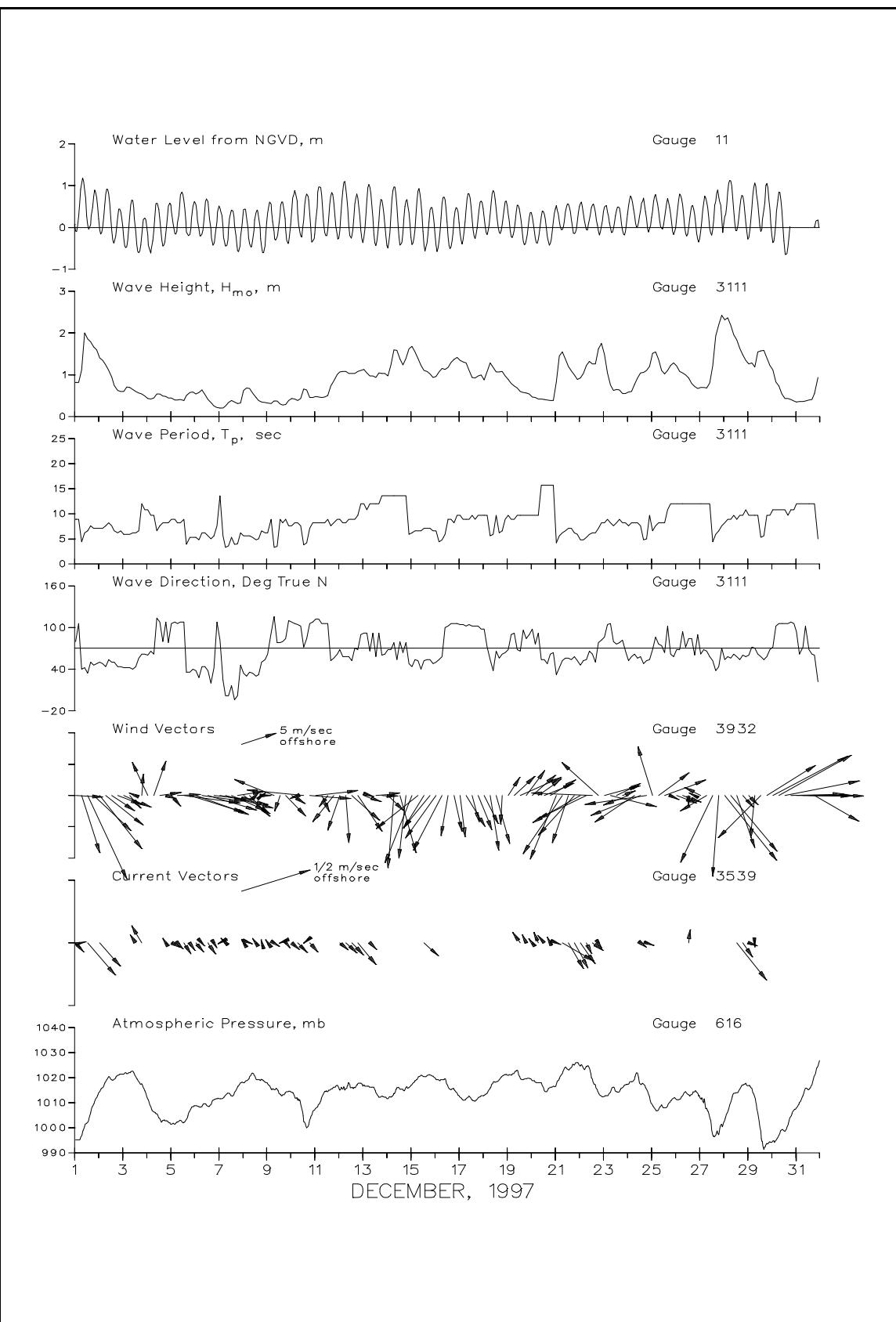


Figure 2. Month at a Glance

Table 1
Instrument Status/Data Availability

		December 1997																																		
		Day of the month																																		
Gauge ID	Description/Remarks	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1				
616	Atmospheric Pressure	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
604	Precipitation	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
624	Air Temperature	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
3932	Anemometer	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
641	Pressure Gauge on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
625	Baylor staff on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
3111	8 Meter Array 309 m north of FRF	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
111	Pressure Gauge center of 8 Meter Array	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
630	Waverider buoy 4.0 km offshore	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
3539	Current meter 343 m north of FRF pier (1.6 km offshore)	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	/	/	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
11	NOAA tide gauge at end of pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Visual Observations (daily oceanographic and meteorological observations)		Daily observation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Gauge Status		*	= Operational	/	= Partial	-	= Non-Operational																													
Data Collected		*	= All	/	= Partial	-	= None																													
Visual Observations		*	= Complete	/	= Partial	-	= None																													

Table 2
Gauge Locations

Gauge*	Description	* Latitude	* Longitude	* FRF Coordinates	* Gauge Depth	* Water Depth
ID *		* Degrees N	* Degrees W	* CrossshoreT Longshore*	NGVD, m	* NGVD, m
		*	*	*	m	*
616	* Atmospheric Pressure*	36 10' 57.03"	* 75 45' 5.50"	* 11.60 *	569.00	* ----- * -----
	*	*	*	*	*	*
3932	* Anemometer	* 36 11' 1.23"	* 75 44' 43.07"	* 585.20 *	517.30	* 19.50 * -----
	*	*	*	*	*	*
641	* Pressure Gauge	* 36 10' 57.71"	* 75 44' 56.23"	* 239.11 *	516.64	* -1.64 * -1.96
	*	*	*	*	*	*
625	* Baylor Staff	* 36 11' 1.04"	* 75 44' 43.72"	* 568.00 *	516.64	* Surface * -8.36
	*	*	*	*	*	*
3111	* 8 Meter Array North	* 36 11' 19.14"	* 75 44' 36.41"	* 915.23 *	990.16	* -7.50 * -7.90
	*	*	*	*	*	*
	* 8 Meter Array South	* 36 11' 11.28"	* 75 44' 33.28"	* 914.20 *	735.37	* -7.42 * -7.90
	*	*	*	*	*	*
	* 8 Meter Array East	* 36 11' 13.70"	* 75 44' 32.56"	* 954.51 *	800.58	* -7.62 * -8.13
	*	*	*	*	*	*
	* 8 Meter Array West	* 36 11' 12.48"	* 75 44' 37.11"	* 834.66 *	800.37	* -6.98 * -7.44
	*	*	*	*	*	*
111	* Pressure Gauge in center of 8 M Array	* 36 11' 14.06"	* 75 44' 34.39"	* 914.43 *	825.52	* -7.76 * -8.08
	*	*	*	*	*	*
630	* Waverider Buoy	* 36 10' 5.10"	* 75 41' 59.30"	* 3934.96 * -2400.81	*	Surface * -17.00
	*	*	*	*	*	*
3539	* Current Meter	* 36 11' 23.57"	* 75 44' 9.12"	* 1605.80 *	907.60	* -11.60 * -11.70
	*	*	*	*	*	*
11	* NOAA Tide Gauge	* 36 11' 1.25"	* 75 44' 42.60"	* 596.49 *	514.20	* Surface * -7.62
	*	*	*	*	*	*
R	R	R	R	R	R	R

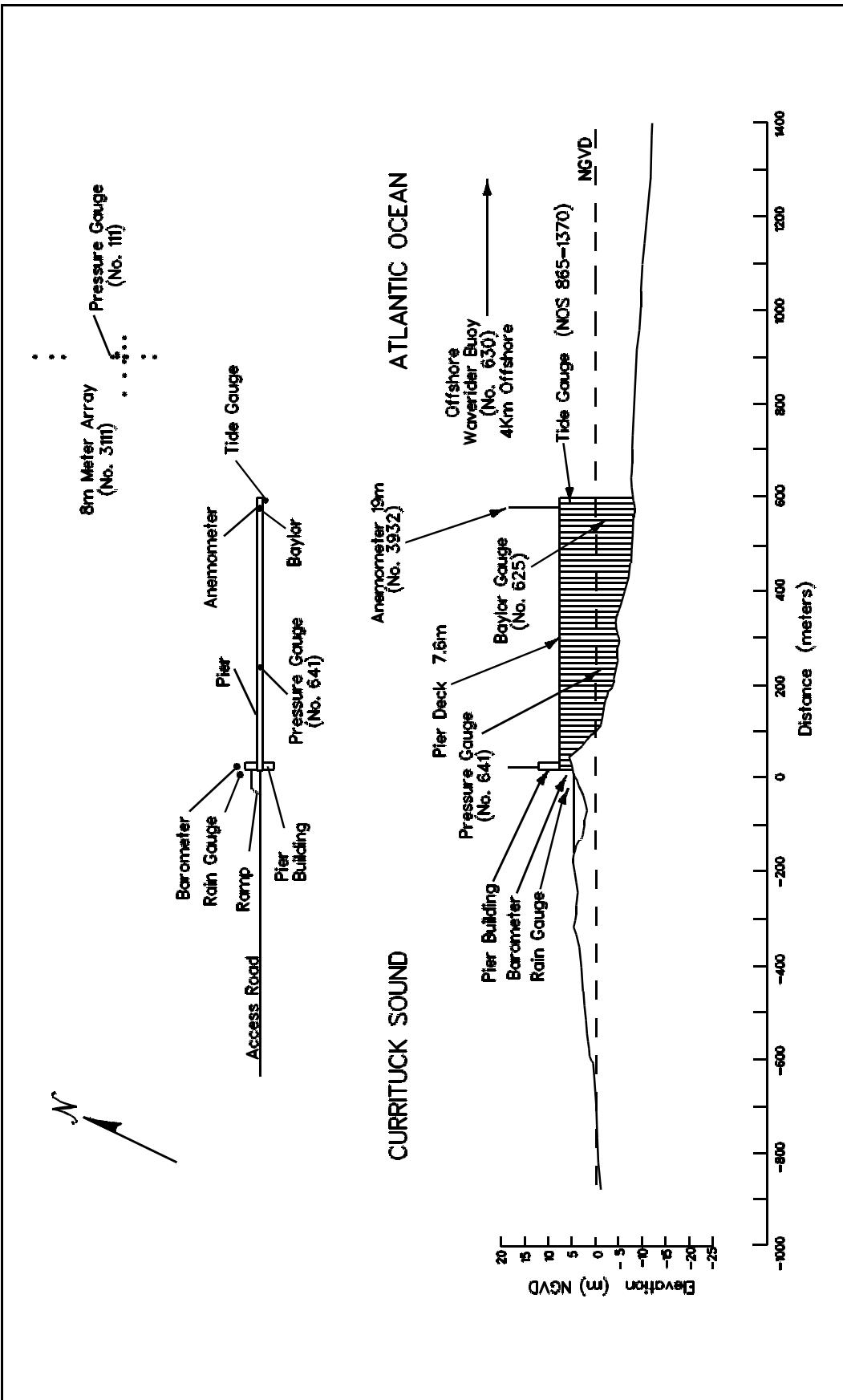


Figure 3. Instrument Locations, Elevations From NGVD

Meteorological Data

2

A variety of instruments have been installed at the FRF (Figure 3) to monitor the meteorological conditions. The data presented in Table 3 are collected and stored using a Digital Equipment Corporation VAXstation 4000. For each instrument identified in Table 1, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m using a WeatherMeasure Skyvane anemometer. Monthly resultant wind speeds and directions (Figure 4) are determined by vector averaging the data. Wind directions (Table 3) indicate where the wind is coming from. Temperature and atmospheric pressure means (Table 3) are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 3 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
 $mm \times .03937 = in.$
2. Millibars (mb) to inches of mercury (in. Hg) -
 $mb \times 0.02953 = in. Hg$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -
 $m/s \times 1.943 = kn$

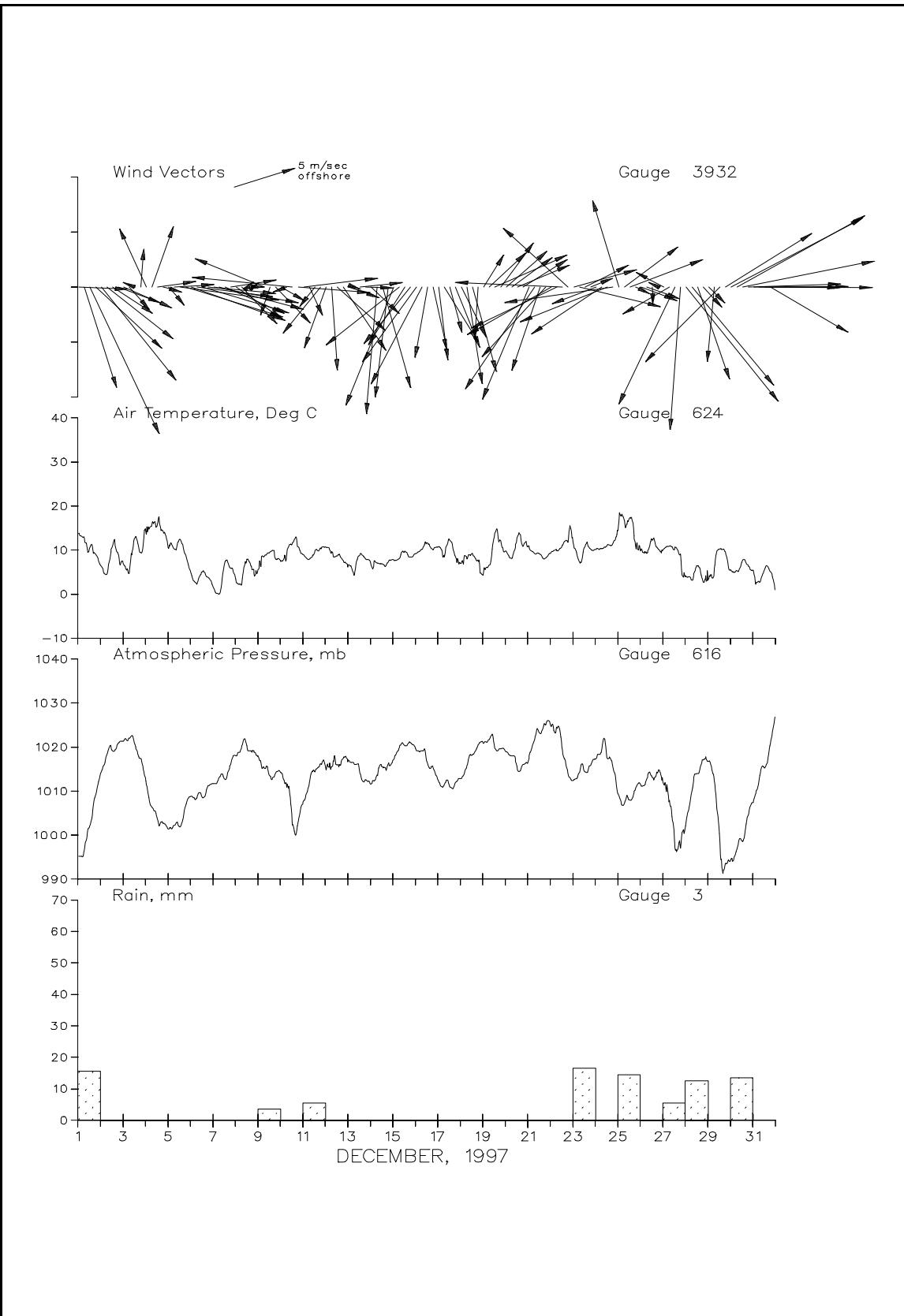


Figure 4. Meteorological Monthly Summary

Table 3
Meteorological Data

Dec 1997						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	4	272	13.8	995.2	0
	700	9	344	12.7	996.7	15
	1300	14	337	10.7	1002.2	0
	1900	8	317	9.1	1009.4	0
2	100	10	325	6.2	1014.5	0
	700	7	312	4.6	1018.4	0
	1300	4	307	11.0	1019.2	0
	1900	4	1	9.1	1020.9	0
3	100	4	296	6.7	1021.4	0
	700	3	322	4.8	1022.1	0
	1300	1	114	12.9	1020.5	0
	1900	3	183	9.5	1017.5	0
4	100	6	158	13.6	1011.4	0
	700	6	197	15.9	1006.4	0
	1300	3	260	16.0	1003.6	0
	1900	1	1	14.2	1002.7	0
5	100	2	323	10.4	1001.4	0
	700	3	1	10.3	1002.3	0
	1300	8	278	12.4	1001.9	0
	1900	8	289	8.9	1006.8	0
6	100	8	1	4.5	1008.9	0
	700	6	1	2.2	1008.5	0
	1300	7	1	5.1	1008.6	0
	1900	5	276	3.8	1011.3	0
7	100	7	282	1.2	1011.7	0
	700	7	287	-0.1	1013.1	0
	1300	5	1	7.5	1012.7	0
	1900	4	259	5.9	1016.2	0
8	100	5	308	2.7	1018.0	0
	700	4	320	2.4	1020.3	0
	1300	1	220	7.9	1019.5	0
	1900	1	228	5.7	1019.3	0
9	100	0		5.8	1017.5	0
	700	6	115	8.6	1015.2	4
	1300	3	16	9.6	1013.5	0
	1900	4	320	8.0	1014.2	0
10	100	2	304	7.5	1014.2	0
	700	1	67	9.0	1010.9	0
	1300	8	96	11.5	1002.3	0
	1900	6	275	10.7	1003.3	0

Table 3
Meteorological Data (continued)

Dec 1997						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
11	100	6	1	8.9	1007.9	0
	700	3	338	8.0	1012.1	6
	1300	2	34	9.9	1014.5	0
	1900	5	34	10.5	1016.2	0
12	100	6	17	10.6	1014.9	0
	700	8	356	9.7	1015.5	0
	1300	5	316	8.6	1016.1	0
	1900	7	329	7.6	1017.5	0
13	100	3	1	6.7	1017.0	0
	700	0		4.3	1016.2	0
	1300	3	263	8.9	1014.1	0
	1900	2	271	8.1	1012.6	0
14	100	3	317	6.6	1011.6	0
	700	12	4	7.0	1013.8	0
	1300	9	346	6.9	1015.5	0
	1900	10	5	7.3	1016.3	0
15	100	11	19	7.8	1017.3	0
	700	8	47	8.1	1019.9	0
	1300	6	28	9.8	1020.4	0
	1900	6	35	8.4	1021.0	0
16	100	8	31	9.3	1019.3	0
	700	10	24	10.1	1019.2	0
	1300	6	8	11.6	1016.4	0
	1900	6	349	10.0	1015.3	0
17	100	7	353	10.7	1012.2	0
	700	6	332	8.4	1011.5	0
	1300	4	347	12.2	1011.0	0
	1900	6	340	8.6	1012.0	0
18	100	5	336	7.0	1013.0	0
	700	9	352	8.0	1015.9	0
	1300	8	346	9.2	1018.4	0
	1900	5	3	7.7	1020.6	0
19	100	3	208	5.2	1020.9	0
	700	4	222	6.6	1021.8	0
	1300	6	242	13.8	1019.8	0
	1900	5	212	12.0	1019.7	0
20	100	5	224	9.7	1018.9	0
	700	4	229	8.1	1018.1	0
	1300	4	243	12.9	1014.9	0
	1900	4	233	10.9	1016.2	0

Table 3
Meteorological Data (concluded)

Dec 1997						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
21	100	11	19	10.9	1017.5	0
	700	11	30	9.2	1021.7	0
	1300	8	16	9.1	1023.2	0
	1900	8	38	8.2	1025.1	0
22	100	8	56	9.5	1024.7	0
	700	8	60	9.8	1024.6	0
	1300	8	92	11.2	1019.4	0
	1900	7	136	11.8	1014.1	0
23	100	5	252	10.7	1012.5	0
	700	7	1	7.3	1014.3	17
	1300	4	239	10.8	1014.5	0
	1900	2	245	10.3	1015.9	0
24	100	4	66	10.1	1017.5	0
	700	7	52	10.3	1019.5	0
	1300	8	65	11.2	1017.5	0
	1900	9	1	11.5	1015.5	0
25	100	8	165	16.6	1009.1	0
	700	6	228	16.7	1007.2	15
	1300	6	246	17.3	1008.0	0
	1900	1	299	11.0	1010.7	0
26	100	3	1	10.3	1011.2	0
	700	3	1	9.3	1012.8	0
	1300	2	358	12.2	1013.1	0
	1900	1	120	10.3	1014.5	0
27	100	3	121	10.3	1011.5	0
	700	4	55	10.9	1007.9	6
	1300	11	22	10.7	997.1	0
	1900	13	3	9.1	997.1	0
28	100	13	1	4.0	1003.1	0
	700	11	324	3.1	1010.3	12
	1300	9	343	6.4	1014.1	0
	1900	2	321	2.8	1017.1	0
29	100	2	319	3.5	1016.8	0
	700	7	1	5.9	1012.3	0
	1300	9	40	10.3	998.6	0
	1900	8	234	9.5	993.7	0
30	100	12	238	5.3	994.8	0
	700	12	237	5.3	997.0	14
	1300	11	257	7.7	998.6	0
	1900	7	267	6.6	1004.5	0
31	100	9	270	4.8	1008.1	0
	700	7	269	2.7	1012.9	0
	1300	6	270	5.8	1015.3	0
	1900	7	304	5.1	1020.9	0
		Resultant		Mean	Mean	Total
		3	332	8.7	1013.0	89

Wave Data

3

Wave data are collected from three different sets of instruments, as shown in Table 1 and Figure 3. The first is an array of fifteen pressure gauges, collectively referred to as gauge 3111 (gauge 111 being one of them). Directional information is computed from these gauges using an iterative maximum likelihood estimator. The second is a Baylor staff gauge (625) and a pressure gauge (641), both attached to the pier. The third is a Waverider buoy (630). The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAXstation 4000. Data is sampled at 2 hertz, with five contiguous 34 minute records, for a total collection period of nearly 2 hours and 51 minutes. This report reflects the data collection periods of 0100, 0700, 1300, and 1900 EST. The results are based only on the first 34 minute record. The exception is the 8 Meter Array (3111) which condenses the first four records into one statistical value.

Wave height H_{mo} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gauge has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 degrees of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum.

Table 4 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 4 are average values computed from this data. Figure 5 is a time history of all H_{mo} and T_p values obtained for all gauges.

Differences in wave periods between wave gauges (Table 4 and Figure 5) may be the result of wave breaking, wave reformation, the presence of multiple wave trains containing nearly equal energy, and statistical variations in spectral estimations.

Table 4
Wave Data

Dec 1997												
Day	Hour	641 Pressure Gauge			625 Baylor Gauge			3111 8 Meter Array			630 Waverider	
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec		
1	0100	0.47	10.3	0.73	9.5	0.82	8.9	80	0.95	9.1		
	0700	0.55	8.9	0.61	8.9	1.12	4.4	40	0.93	9.1		
	1300	1.40	7.2	1.59	6.8	1.86	6.6	34	2.35	6.7		
	1900	1.53	7.2	1.44	7.2	1.67	7.1	46	1.93	7.2		
2	0100	1.17	7.6	1.27	8.1	1.41	7.1	50	1.73	7.2		
	0700	1.07	7.8	1.08	8.1	1.23	7.6	44	1.58	8.4		
	1300	0.89	7.4	0.90	8.6	0.94	7.6	50	1.18	7.7		
	1900	0.48	6.5	0.55	6.6	0.62	6.2	44	0.79	6.7		
3	0100	0.45	5.6	0.51	6.1	0.60	5.9	42	0.72	5.6		
	0700	0.61	5.2	0.63	5.7	0.69	5.9	42	0.83	5.6		
	1300	0.41	5.5	0.56	6.0	0.60	6.2	44	0.77	5.9		
	1900	0.30	5.5	0.53	5.6	0.54	12.0	62	0.76	11.2		
4	0100	0.21	6.1	0.38	9.9	0.44	10.8	60	0.51	11.2		
	0700	0.21	9.2	0.47	9.9	0.44	9.8	62	0.53	10.1		
	1300	0.34	7.6	0.45	7.4	0.54	7.6	108	0.63	7.2		
	1900	0.28	7.2	0.48	8.6	0.48	8.2	108	0.54	8.4		
5	0100	0.28	8.6	0.39	8.6	0.44	8.9	106	0.51	9.1		
	0700	0.23	8.3	0.37	7.8	0.39	8.2	106	0.54	8.4		
	1300	0.24	8.6	0.32	8.1	0.38	8.9	108	0.62	8.4		
	1900	0.40	4.5	0.52	4.2	0.57	5.3	36	0.72	4.1		
6	0100	0.47	5.3	0.42	5.3	0.54	5.3	38	0.81	5.1		
	0700	0.49	5.7	0.55	5.0	0.64	6.2	44	0.83	4.8		
	1300	0.39	5.6	0.35	5.3	0.41	5.6	38	0.74	5.6		
	1900	0.21	5.0	0.24	5.6	0.25	5.6	42	0.56	4.4		
7	0100	0.17	5.3	0.21	2.9	0.20	13.6	82	0.54	3.1		
	0700	0.14	5.2	0.22	2.7	0.25	3.3	2	0.58	2.6		
	1300	0.28	4.9	0.30	4.4	0.38	5.3	16	0.70	4.8		
	1900	0.22	5.0	0.31	5.3	0.31	4.1	2	0.49	4.6		
8	0100	0.52	5.3	0.46	5.7	0.62	5.6	34	0.76	5.9		
	0700	0.65	5.5	0.65	5.6	0.67	5.6	36	0.91	5.6		
	1300	0.38	4.7	0.41	5.0	0.45	4.8	30	0.66	4.4		
	1900	0.22	4.7	0.29	5.0	0.34	6.6	50	0.50	5.1		
9	0100	0.22	5.1	0.29	6.0	0.32	6.2	62	0.40	5.3		
	0700	0.27	2.7	0.43	2.8	0.37	3.3	116	0.48	2.8		
	1300	0.23	3.3	0.30	3.2	0.30	8.9	78	0.44	3.4		
	1900	0.18	5.4	0.36	3.1	0.29	8.9	84	0.38	8.4		
10	0100	0.29	7.2	0.39	7.4	0.43	7.6	108	0.57	7.2		
	0700	0.24	8.1	0.37	8.3	0.38	8.2	104	0.49	6.7		
	1300	0.40	3.5	0.63	3.6	0.65	3.8	72	0.78	3.3		
	1900	0.29	7.2	0.46	4.1	0.45	7.1	106	0.70	7.2		

Table 4
Wave Data (continued)

Dec 1997											
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider		
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec	
11	0100	0.29	7.8	0.36	8.6	0.48	8.2	112	0.63	8.4	
	0700	0.32	8.1	0.35	7.8	0.45	8.2	106	0.61	7.7	
	1300	0.34	4.7	0.44	5.1	0.50	8.9	106	0.62	8.4	
	1900	0.81	7.6	0.70	7.8	0.85	8.2	56	1.02	7.7	
12	0100	0.75	8.3	1.00	8.3	1.06	8.9	68	1.24	8.4	
	0700	0.84	8.1	0.95	8.6	1.08	8.2	58	1.17	7.7	
	1300	0.63	8.9	0.96	9.2	1.03	8.9	52	1.17	7.7	
	1900	0.72	8.3	0.88	8.9	1.07	9.8	68	1.22	9.1	
13	0100	0.83	12.2	1.08	11.2	1.13	12.0	92	1.28	9.1	
	0700	0.65	11.2	0.81	10.7	0.97	12.0	66	1.09	10.6	
	1300	0.56	10.3	0.82	12.2	0.93	12.0	58	0.95	10.6	
	1900	0.65	12.9	0.86	12.9	1.03	13.6	60	1.02	12.6	
14	0100	0.57	14.3	0.88	13.5	0.96	13.6	68	1.00	12.6	
	0700	1.22	5.4	1.22	12.9	1.60	13.6	78	1.66	5.3	
	1300	1.03	12.9	1.36	12.9	1.38	13.6	80	1.57	14.3	
	1900	1.09	5.7	1.11	12.9	1.39	13.6	78	1.41	12.6	
15	0100	1.08	6.0	1.51	6.5	1.68	6.2	44	1.81	6.3	
	0700	1.27	6.6	1.22	6.1	1.39	6.6	52	1.70	6.3	
	1300	0.89	6.8	1.12	7.0	1.10	7.1	52	1.39	6.7	
	1900	0.75	7.2	0.87	7.2	1.01	7.1	54	1.26	7.2	
16	0100	0.66	5.7	0.89	7.2	0.95	6.6	50	1.21	7.2	
	0700	0.74	4.7	0.98	4.1	1.15	4.8	58	1.36	4.2	
	1300	0.63	7.6	1.09	6.8	1.17	8.9	102	1.37	8.4	
	1900	0.82	9.2	1.25	8.9	1.37	8.2	106	1.54	9.1	
17	0100	0.80	9.9	1.27	8.9	1.35	9.8	104	1.65	10.1	
	0700	0.75	9.5	1.10	9.5	1.28	8.9	102	1.61	9.1	
	1300	0.51	10.3	0.92	8.3	0.93	9.8	102	1.15	10.1	
	1900	0.53	9.2	0.88	9.5	0.98	9.8	102	1.13	8.4	
18	0100	0.47	9.9	0.94	9.9	0.88	9.8	98	1.03	10.1	
	0700	0.87	5.1	1.17	4.9	1.29	5.6	54	1.42	5.3	
	1300	0.79	6.1	0.90	6.0	1.07	9.8	66	1.25	10.1	
	1900	0.70	5.6	1.00	7.8	1.08	6.6	62	1.18	7.7	
19	0100	0.60	7.4	0.83	9.5	0.88	9.8	68	0.99	7.7	
	0700	0.36	16.0	0.63	9.2	0.74	8.9	92	0.77	9.1	
	1300	0.32	9.5	0.56	9.9	0.60	9.8	66	0.66	9.1	
	1900	0.24	9.5	0.42	9.2	0.56	9.8	84	0.55	9.1	
20	0100	0.24	15.1	0.39	9.2	0.47	9.8	98	0.50	9.1	
	0700	0.20	17.1	0.38	17.1	0.42	9.8	92	0.45	18.2	
	1300	0.23	16.0	0.29	17.1	0.40	15.7	54	0.45	16.7	
	1900	0.21	16.0	0.33	16.0	0.39	15.7	62	0.40	15.4	

Table 4
Wave Data (concluded)

Dec 1997											
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider		
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec	
21	0100	0.28	16.0	0.35	16.0	0.83	4.2	32	0.39	15.4	
	0700	1.13	5.9	1.33	5.7	1.55	6.2	52	1.59	6.3	
	1300	1.05	6.3	1.02	7.0	1.20	7.1	56	1.59	6.7	
	1900	0.80	6.5	0.92	6.5	1.00	6.2	58	1.27	6.7	
22	0100	0.69	4.9	0.82	4.9	0.92	4.8	46	1.10	5.9	
	0700	0.73	5.4	1.12	5.2	1.22	5.3	54	1.35	5.1	
	1300	0.89	6.0	1.25	5.7	1.26	6.2	62	1.60	5.9	
	1900	0.86	6.8	1.42	7.0	1.62	7.1	78	1.62	5.9	
23	0100	0.99	8.3	1.38	8.3	1.48	8.2	86	inoperative		
	0700	0.41	8.3	0.74	7.8	0.75	8.2	106	0.77	7.7	
	1300	0.37	8.6	0.50	8.6	0.64	8.2	76	0.73	9.1	
	1900	0.28	8.1	0.79	8.3	0.55	8.2	82	0.66	7.2	
24	0100	0.35	7.6	0.43	8.1	0.59	7.6	52	0.68	7.2	
	0700	0.47	7.2	0.66	7.6	0.76	8.2	62	0.70	8.4	
	1300	0.70	7.4	0.94	7.8	1.04	7.6	58	1.23	6.3	
	1900	0.73	5.3	1.08	5.1	1.10	5.0	52	1.39	4.8	
25	0100	0.96	6.1	1.28	5.5	1.52	6.6	68	1.94	5.6	
	0700	0.89	8.9	1.42	8.6	1.36	8.2	76	1.75	8.4	
	1300	0.57	8.6	0.92	8.9	1.02	8.2	64	1.27	8.4	
	1900	0.73	12.2	1.05	12.9	1.22	12.0	62	1.37	10.1	
26	0100	0.73	11.7	1.05	11.7	1.22	12.0	68	1.34	11.8	
	0700	0.59	13.5	0.89	12.9	1.04	12.0	94	1.08	11.2	
	1300	0.47	12.2	0.80	12.2	0.92	12.0	84	0.98	12.6	
	1900	0.34	12.2	0.60	11.7	0.73	12.0	60	0.77	11.8	
27	0100	0.32	12.9	0.71	11.2	0.69	12.0	62	0.69	11.2	
	0700	0.37	11.7	0.54	11.7	0.69	12.0	66	0.72	10.6	
	1300	0.58	4.1	0.98	4.1	1.22	4.4	52	1.06	11.8	
	1900	1.33	6.5	1.64	6.6	2.19	6.6	44	2.16	5.9	
28	0100	1.30	8.1	2.13	8.1	2.32	8.2	54	2.78	7.7	
	0700	1.68	9.2	2.01	9.2	2.18	8.9	56	2.66	9.1	
	1300	1.04	9.9	1.66	9.2	1.83	8.9	58	2.06	9.1	
	1900	1.15	9.9	1.28	10.3	1.48	9.8	60	1.54	10.6	
29	0100	0.86	9.9	1.13	10.3	1.26	9.8	60	1.30	10.1	
	0700	0.90	10.3	1.09	9.5	1.19	9.8	70	1.37	11.2	
	1300	0.97	5.0	1.54	9.5	1.57	5.3	58	1.80	10.1	
	1900	1.07	5.7	1.28	5.7	1.40	9.8	58	1.61	10.6	
30	0100	0.66	10.3	1.19	10.3	1.12	10.8	72	1.40	10.6	
	0700	0.48	10.7	0.71	10.7	0.73	10.8	106	1.03	10.1	
	1300	0.20	10.3	0.51	10.7	0.43	10.8	106	0.74	10.6	
	1900	0.25	11.7	0.37	11.2	0.41	10.8	108	0.60	10.1	
31	0100	0.14	15.1	0.37	12.9	0.35	12.0	94	0.56	12.6	
	0700	0.22	12.2	0.31	12.2	0.36	12.0	72	0.55	14.3	
	1300	0.18	12.2	0.39	12.2	0.39	12.0	68	0.56	12.6	
	1900	0.32	4.1	0.49	12.2	0.54	12.0	60	0.69	11.2	
Mean		0.60	8.2	0.80	8.3	0.90	8.5	67	1.05	8.4	
Std dev		0.34	3.1	0.41	3.0	0.46	2.7	24	0.50	2.9	

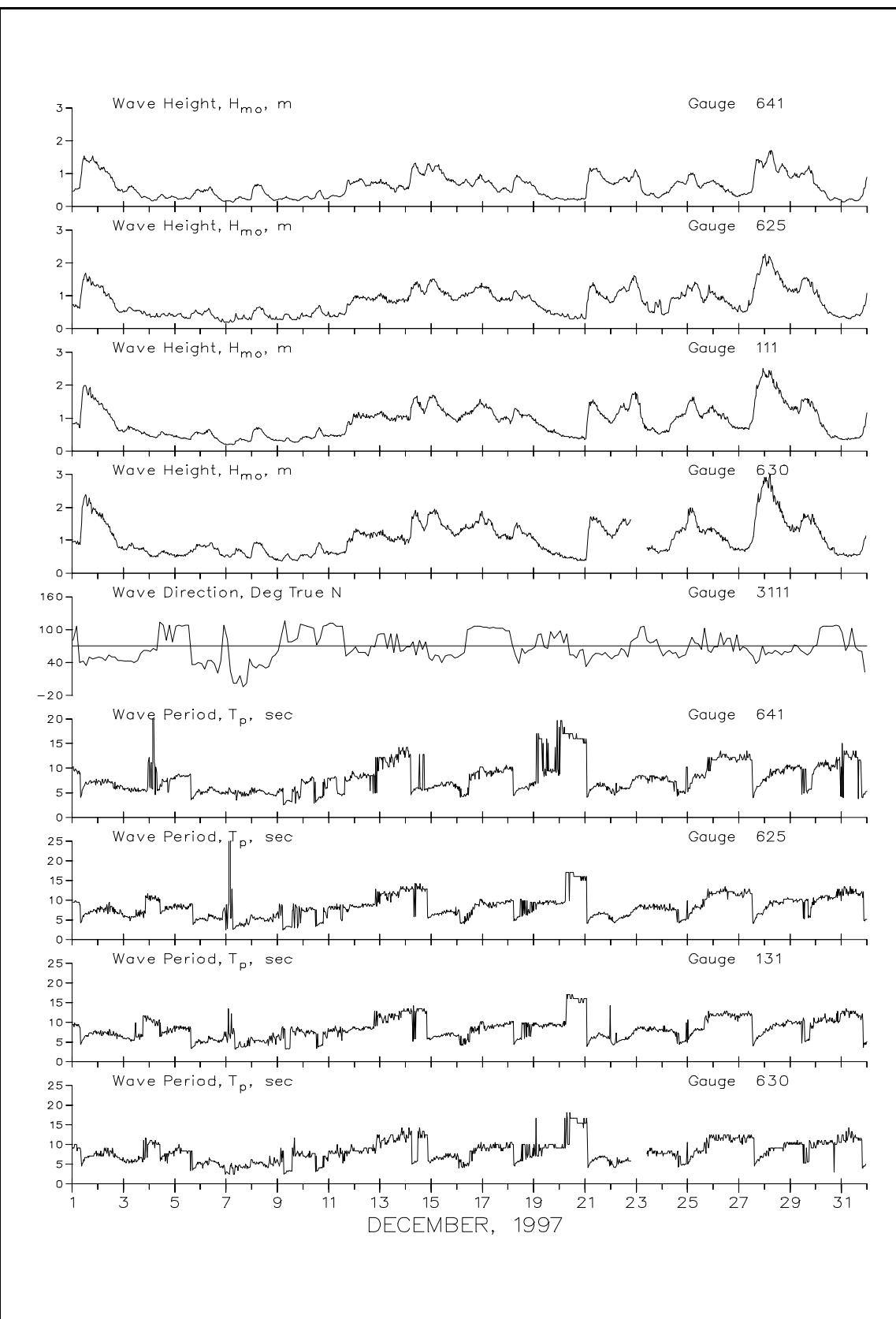


Figure 5. Wave Heights and Periods

Current Data

4

Current data (Table 5) are collected from a Marsh-McBirney electromagnetic biaxial current meter and by visually observing the movement of small drogues on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier, approximately 12 m offshore (Table 6).

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward). All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the cross-shore and longshore data. Current directions indicate the direction that the current is moving towards. Current data are plotted in Figure 2.

Table 5
Current Meter Data - Gauge 3539

DECEMBER 1997																	
	Cross Long				Cross Long				Cross Long				Cross Long				
Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir
1	100	-2	9	9	142	1300		inoperative				22	100	-3	19	19	149
	700	-2	0	3	76	1900							700	0	9	9	157
	1300	-8	31	32	143	12	100	-2	7	8	135		1300	-4	8	9	128
	1900						700	-3	10	11	137		1900	0	4	4	150
2	100	-6	22	23	143	1300	-3	12	12	140		23	100				
	700					1900	-5	21	21	144			700				
	1300					13	100						1300	inoperative			
	1900		inoperative			700	-1	6	7	139			1900				
3	100					1300						24	100				
	700					1900							700				
	1300	1	-7	8	330	14	100		inoperative				1300	-2	5	6	130
	1900	2	-14	15	333	700							1900	-3	4	5	114
4	100					1300						25	100				
	700		inoperative			1900							700				
	1300					15	100						1300				
	1900	1	-3	4	331	700							1900				
5	100	-3	6	7	122	1300	-5	13	15	137		26	100		inoperative		
	700	-1	6	6	143	1900							700				
	1300	-1	10	10	150	16	100						1300	-4	-9	11	6
	1900	0	7	7	150	700							1900				
6	100	-2	9	9	142	1300						27	100				
	700	0	3	3	143	1900		inoperative					700				
	1300	-1	10	10	148	17	100						1300	inoperative			
	1900	0	4	4	152	700							1900				
7	100	1	0	1	237	1300						28	100				
	700	2	-4	5	318	1900							700				
	1300					18	100						1300	-8	35	36	145
	1900		inoperative			700							1900	-2	13	13	149
8	100	1	-2	3	330	1300						29	100	-4	4	7	112
	700	0	1	2	115	1900							700	1	3	3	177
	1300	1	-3	4	329	19	100						1300				
	1900	0	-1	2	345	700							1900				
9	100	1	-2	3	328	1300	2	-9	10	327		30	100				
	700	-2	4	5	125	1900	0	-6	7	337			700				
	1300	0	0	0		20	100	1	-3	4	326		1300				
	1900	0	5	5	144	700	0	-8	9	341			1900				
10	100	-2	7	7	136	1300	2	-6	7	323		31	100		inoperative		
	700	-2	10	10	141	1900	0	-4	5	335			700				
	1300	0	0	0		21	100	-1	2	3	116		1300				
	1900	-2	9	9	144	700	-14	21	26	124			1900				
11	100					1300	-2	23	23	153							
	700		inoperative			1900	-1	22	22	155							

KEY:

- +cross-shore = offshore, cm/sec
- cross-shore = onshore, cm/sec
- +longshore = south, cm/sec
- longshore = north, cm/sec
- Speed = Resultant speed, cm/sec
- Dir = Resultant direction, degrees true north

Table 6
Visually Observed Current Data

Day	Dec 1997											
	Pier End				Mid-Surf Zone				Beach			
	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir	
1	0	68	68	160	0	152	152	160	North	107	S	
2	4	44	44	154	-37	61	71	191	North	55	S	
3	7	-22	23	357	-3	18	19	169	North	58	S	
4	6	-55	56	346	1	-23	23	343	South	14	N	
5	7	23	24	143	5	-17	18	357	South	14	N	
6	17	28	32	129	-4	44	44	166	North	18	S	
7	3	17	17	151	5	23	23	149	North	48	S	
8	5	11	12	136	-2	44	44	163	North	64	S	
9	-25	-20	33	289	-6	-61	61	334	South	27	N	
10	-11	38	40	177	-8	-55	56	331	South	31	N	
11	11	36	37	143	10	-20	22	7	South	18	N	
12	-3	51	51	163	-8	41	41	171	North	25	S	
13	6	15	16	138	25	-51	57	7	South	18	N	
14	-14	68	69	171	-24	122	124	171	North	63	S	
15	-16	36	39	184	-27	76	81	179	North	66	S	
16	12	41	42	143	5	-36	36	349	South	15	N	
17	-2	44	44	163	-14	-68	69	329	South	16	N	
18	-17	68	70	174	-24	34	41	195	North	44	S	
19	7	-18	20	2	6	-10	11	11	South	20	N	
20	8	-18	20	4	8	-28	29	357	South	24	N	
21	-6	55	56	166	-7	47	47	169	North	47	S	
22	-5	11	12	187	-6	12	14	184	North	11	S	
23	3	6	7	136	15	-23	28	13	South	6	N	
24	-7	23	24	177	-8	51	51	169	North	11	S	
25	-2	-12	12	331	-2	-44	44	337	South	23	N	
26	4	-5	7	17	-7	-47	47	331	South	11	N	
27	-5	12	13	184	30	41	51	123	North	18	S	
28	-4	87	87	163	-24	122	124	171	North	44	S	
29	-6	38	39	169	-11	55	57	171	North	34	S	
30	30	-61	68	7	13	-21	25	11	South	12	N	
31	9	-12	14	17	0	0	0	0	South	3	N	

KEY:

- +cross-shore = offshore, cm/sec
- cross-shore = onshore, cm/sec
- +longshore = south, cm/sec
- longshore = north, cm/sec
- Speed = Resultant speed, cm/sec
- Dir = Resultant direction, degrees true north

Visual Observations

5

Visual wave direction measurements (Table 7) of both the primary wave train (i.e. that having the higher wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The pier axis (considered perpendicular to the beach at the FRF) is oriented 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and depth of visibility are also taken daily at the seaward end of the pier. A Bucket Thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The temperature is then read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the depth of visibility.

Table 7
Visual Observations

Dec 1997							
Day	Time	Wave Approach Angle at Pier End (degrees from True N)		Water Characteristics at Pier End			
		Primary	Secondary	Surf Zone Width, m	Temp., C	Density g/cc	Secchi Vis.,m
1	0100	45	160	241	12.2	1.0240	0.6
2	0800	15		61	11.4	1.0240	0.9
3	0900	25		40	11.1	1.0244	1.5
4	0830	105		26	13.1	1.0250	1.8
5	0735	20		37	12.5	1.0252	0.9
6	0900	5		37	10.6	1.0256	0.9
7	1030	0		24	10.8	1.0254	0.9
8	0933	15		61	10.0	1.0254	1.5
9	0830	110		47	10.0	1.0252	0.9
10	0900	105		47	8.9	1.0224	2.7
11	0838	15	90	59	9.7	1.0244	2.1
12	0833	35	80	71	10.0	1.0242	0.9
13	0900	25		57	9.4	1.0242	1.5
14	1045	15		108	8.9	1.0240	0.6
15	0730	30	80	101	8.3	1.0240	0.9
16	0850	40	90	85	8.3	1.0234	1.2
17	0940	110	40	89	8.9	1.0232	0.9
18	0845	20	80	94	8.6	1.0226	0.9
19	0745	80		77	8.3	1.0228	1.5
20	1030	100		41	10.0	1.0250	1.5
21	1100	45		124	8.9	1.0232	1.2
22	0725	60		126	8.3	1.0216	1.2
23	0715	95		79	9.2	1.0239	1.5
24	0645	50		65	9.2	1.0241	1.5
25	0950	100		96	10.6	1.0250	1.8
26	0830	100		87	10.0	1.0245	1.5
27	0930	85		75	10.0	1.0244	1.5
28	1045	55		260	8.3	1.0220	0.9
29	0710	55		84	7.8	1.0210	1.2
30	0730	100		52	8.9	1.0260	0.9
31	0645	85		35	8.3	1.0260	1.2

Water Levels

6

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A NOS acoustic tide gauge (Next Generation Water Level Measurement System, NGWLMS) is used to collect water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 6 along with a list of means and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level. Table 8 contains the range, high, low, and mean water level for each 12.42-hr tidal cycle.

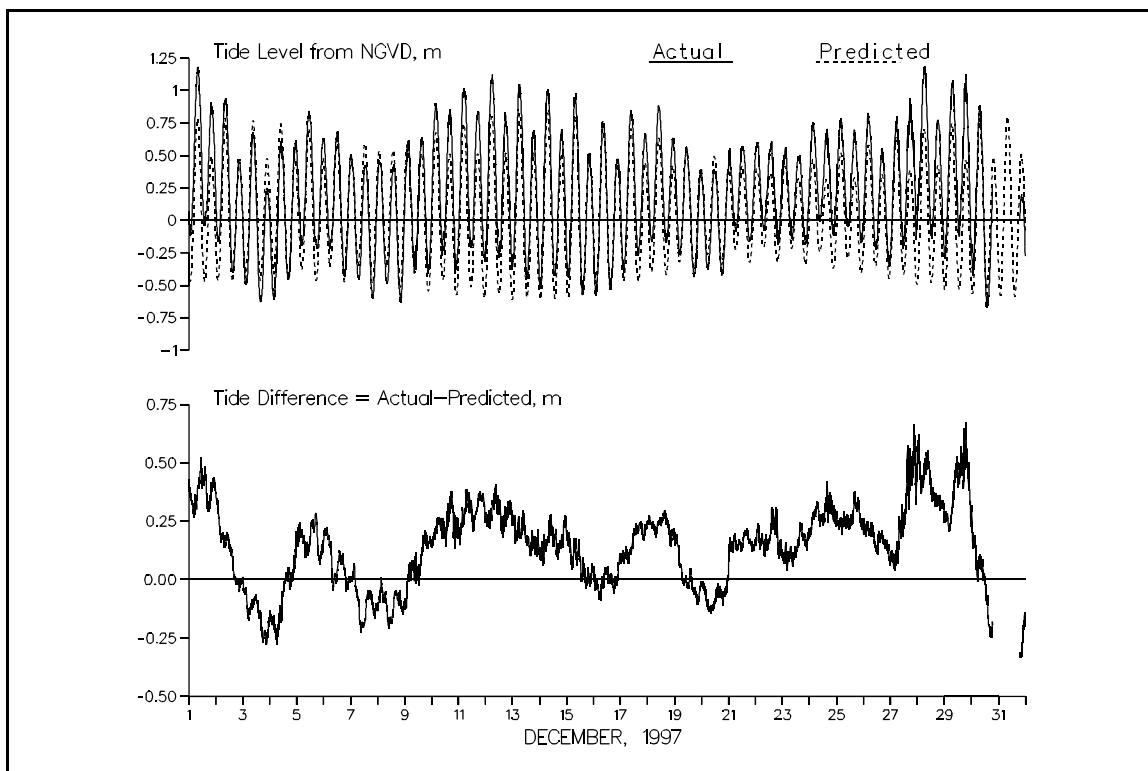


Figure 6. Water Level Variation

Table 8
Water Levels, m NGVD

DEC 1997 Tide Levels																
Day	High			Low			Mean	Range	High			Low			Mean	Range
	Time	m	Day	Time	m	Day			Time	m	Day	Time	m	Day		
1	0800	1.19	1	0124	-0.12	0.55	1.31	16	2054	0.48	16	1442	-0.54	-0.01	1.01	
1	1954	0.91	1	1418	-0.05	0.41	0.95	17	0912	0.84	17	0254	-0.40	0.24	1.24	
2	0836	0.94	2	0212	-0.17	0.38	1.11	17	2212	0.67	17	1548	-0.27	0.21	0.94	
2	2018	0.46	2	1524	-0.41	0.04	0.87	18	1000	0.88	18	0354	-0.17	0.35	1.05	
3	0918	0.68	3	0236	-0.49	0.06	1.17	18	2218	0.64	18	1706	-0.17	0.22	0.81	
3	2148	0.25	3	1542	-0.63	-0.18	0.88	19	1030	0.56	19	0448	-0.27	0.14	0.83	
4	0948	0.61	4	0400	-0.61	0.00	1.22	19	2330	0.40	19	1718	-0.44	-0.03	0.83	
4	2330	0.62	4	1600	-0.45	0.07	1.07	20	1100	0.39	20	0600	-0.38	0.01	0.77	
5	1100	0.85	5	0436	-0.20	0.32	1.05	21	0054	0.55	20	1800	-0.43	0.04	0.98	
5	2354	0.63	5	1824	-0.22	0.20	0.85	21	1236	0.57	21	0648	-0.09	0.25	0.65	
6	1206	0.69	6	0530	-0.22	0.21	0.90	22	0200	0.60	21	1912	-0.16	0.22	0.77	
7	0000	0.51	6	1830	-0.43	0.05	0.94	22	1424	0.61	22	0806	-0.08	0.26	0.69	
7	1242	0.43	7	0706	-0.46	-0.01	0.88	23	0230	0.56	22	2030	-0.19	0.19	0.75	
8	0130	0.47	7	1942	-0.61	-0.05	1.07	23	1512	0.50	23	0848	-0.14	0.20	0.64	
8	1430	0.43	8	0818	-0.49	-0.03	0.92	24	0300	0.75	23	2030	-0.19	0.29	0.94	
9	0336	0.62	8	2030	-0.63	0.00	1.25	24	1600	0.70	24	0924	-0.01	0.33	0.72	
9	1518	0.64	9	0842	-0.41	0.14	1.05	25	0400	0.79	24	2112	-0.12	0.34	0.91	
10	0348	0.90	9	2054	-0.41	0.26	1.31	25	1554	0.70	25	1036	-0.05	0.29	0.75	
10	1624	0.86	10	0936	-0.27	0.29	1.13	26	0412	0.83	25	2142	-0.18	0.32	1.00	
11	0436	1.02	10	2112	-0.39	0.34	1.42	26	1624	0.56	26	1112	-0.22	0.17	0.79	
11	1742	0.84	11	1112	-0.21	0.30	1.05	27	0536	0.80	26	2248	-0.36	0.21	1.16	
12	0554	1.12	11	2342	-0.32	0.40	1.44	27	1754	0.94	27	1112	-0.22	0.35	1.16	
12	1730	0.83	12	1154	-0.28	0.26	1.11	28	0642	1.19	27	2254	-0.15	0.58	1.34	
13	0612	1.05	12	2342	-0.38	0.34	1.43	28	1754	0.77	28	1248	-0.14	0.35	0.91	
13	1848	0.69	13	1248	-0.45	0.13	1.14	29	0730	1.08	29	0018	-0.29	0.41	1.37	
14	0718	1.01	14	0054	-0.52	0.27	1.53	29	1918	1.13	29	1312	-0.12	0.46	1.25	
14	1924	0.70	14	1330	-0.43	0.14	1.13	30	0736	0.89	30	0118	-0.43	0.24	1.32	
15	0812	0.98	15	0130	-0.44	0.25	1.42	30	1942		30	1348	No data this cycle			
15	1948	0.52	15	1406	-0.57	0.00	1.09	31	806		31	142	No data this cycle			
16	0818	0.75	16	0200	-0.58	0.10	1.33	31	2030		31	1430	No data this cycle			

Bathymetry

7

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using a Trimble 4000 SSE GPS for positioning, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 7 shows the last survey in November and the survey(s) in December on profile line 188, located 517 m south of the pier.

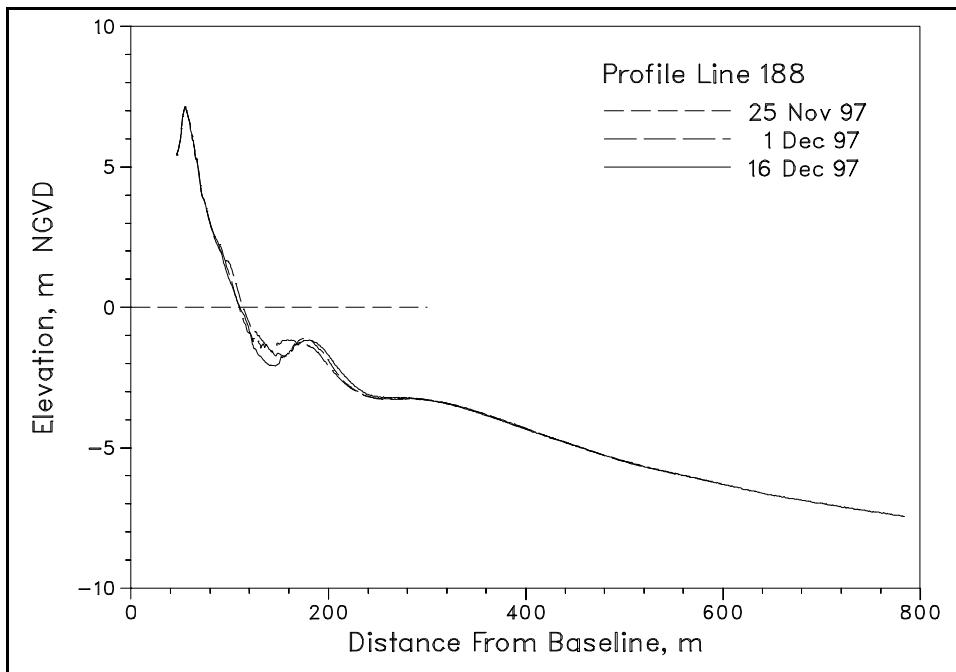


Figure 7. Monthly CRAB Profiles on Profile Line 188.

The profile envelope (Figure 8) reflects the maximum changes that occurred on the profile during 1997. Cross-hatched areas indicate changes to the annual envelope which occurred in December.

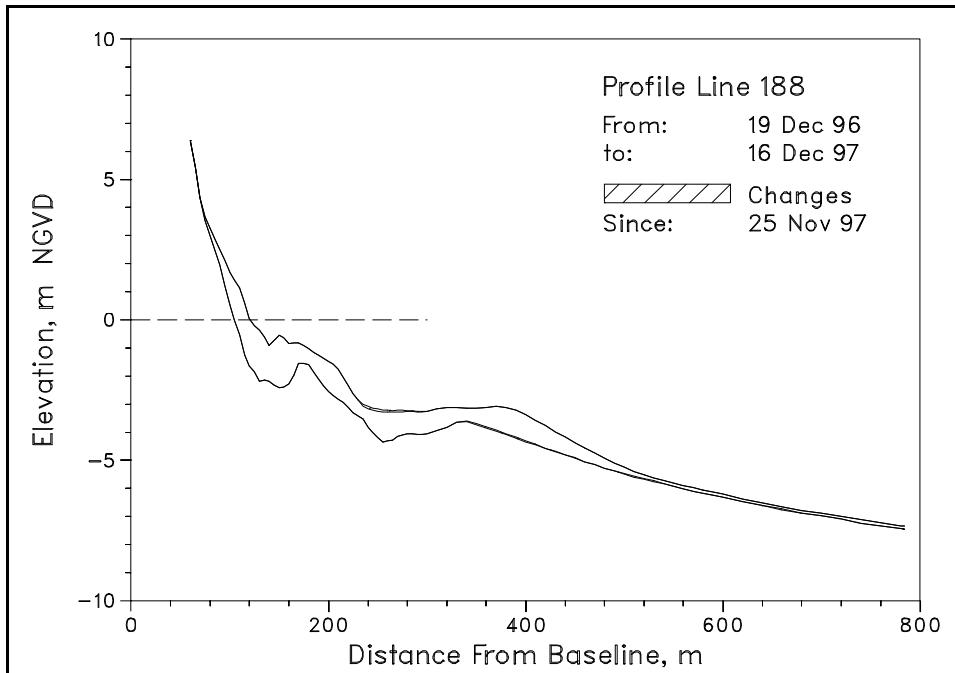
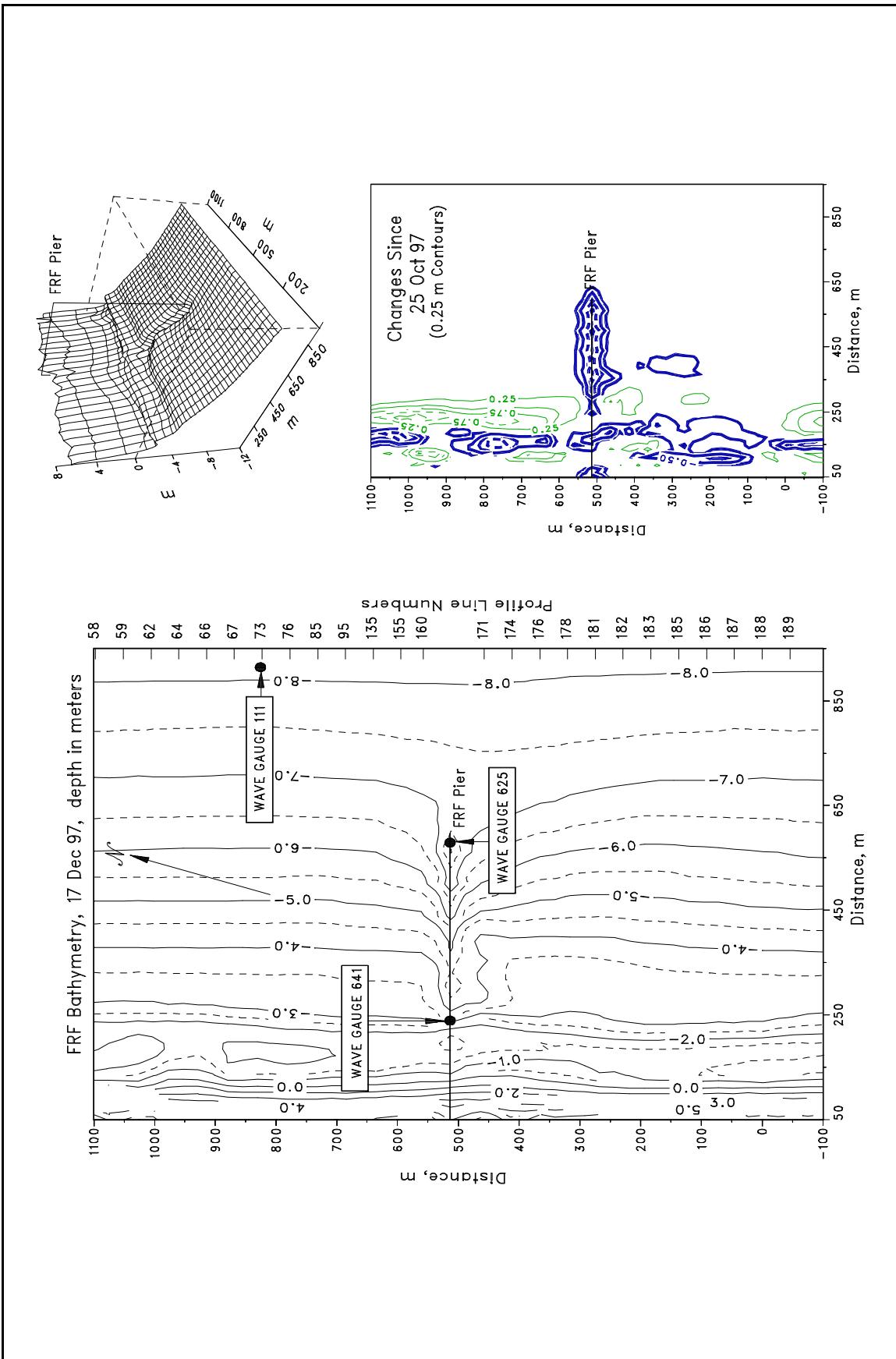


Figure 8. Profile Envelope - Profile Line 188.

B. Bathymetry. Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 17 December. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.



Special Events

8

A. Storm Data Collection. The following list identifies times when the wave height H_{mo} at the seaward end of the pier exceeded 2 m.

	<u>Start</u>	<u>End</u>
	27 Dec (2200)	28 Dec (0700)

B. Storm Synopsis.

Northeasterly winds were funneled between a Canadian high pressure system and a low pressure system off the South Carolina coast. Winds shifted seaward as the low pressure system began moving out to sea by the afternoon of 27 December. Maximum onshore winds (NE) reached 13 m/s at 1600 EST on 27 December. The minimum atmospheric pressure was 996 mb. The maximum H_{mo} , at gauge 625, reached 2.27 m ($T_p=7.6$ s) at 0016 EST on 28 December. There was 18 mm of precipitation.